23. Measure AD and OD
From similar triangles

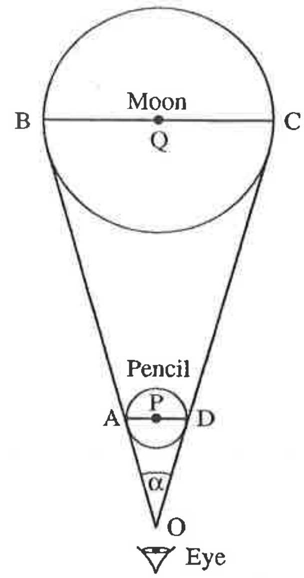
$$\frac{OP}{OQ} \simeq \frac{AD}{BC}$$

$$\Rightarrow BC \simeq \frac{(OQ)(AD)}{OP}$$

$$BC \simeq \frac{(3.8 \times 10^8 \text{ m})AD}{OP}$$

$AD \simeq 5$ mm and $OP \simeq 0.5$ m

$$BC \simeq \frac{(3.8 \times 10^8)(5 \times 10^{-3})}{5 \times 10^{-1}} = \underline{3.5 \times 10^6 \text{ m}}$$



24. Problem is subjective
Estimated 15 000 students, 2000 employees.
Assume 1500 employees drive, 3000 students drive
Average distance = 2 miles/trip × 2 trips/day = 4 miles/day
Cars get 20 mi/gal

So $\frac{4 \text{ miles/day}}{20 \text{ mi/gal}} = 0.2$ gal/day

4500 drivers × 0.2 gal/day = <u>900 gal/day</u>

25. Jar is about 8 marbles high 6 marbles in diameter so radius is 3 marbles
Volume = height × area = $8 \times \pi(3)^2 = 8 \times 28 = 226$
Round to <u>230</u> marbles.

Chapter 2

1. $\bar{v} = d/t = (220\ \text{km})/(2.25\ \text{h}) = \underline{97.8\ \text{km/h}}$

2. $d = \bar{v}t = (31.0\ \text{km/h})(135\ \text{min})(1\ \text{hr}/60\ \text{min}) = \underline{69.8\ \text{km}}$

3. $t = d/\bar{v} = (22\ \text{km})/(30\ \text{km/h}) = \underline{0.73\ \text{h}}$

4. $d = \bar{v}t = (100\ \text{km/h})(2\ \text{s})(1\ \text{h}/3600\ \text{s}) = 0.056\ \text{km} = \underline{56\ \text{m}}$

5. (a) $(55\ \text{mi/h})(1\ \text{km}/0.621\ \text{mi}) = \underline{89\ \text{km/h}}$

   (b) $(88.6\ \text{km/h})(1000\ \text{m/km})(1\ \text{h}/3600\ \text{s}) = \underline{25\ \text{m/s}}$

   (c) $(24.6\ \text{m/s})(1\ \text{ft}/0.305\ \text{m}) = \underline{80.7\ \text{ft/s}}$

6. (a) $(1\ \text{km/h})(0.621\ \text{mi}/1\ \text{km}) = \underline{0.621\ \text{mi/h}}$

   (b) $(1\ \text{m/s})(1\ \text{ft}/0.305\ \text{m}) = \underline{3.28\ \text{ft/s}}$

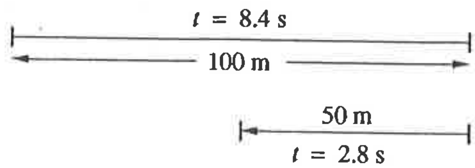
   (c) $(1\ \text{mi/h})(1000\ \text{m}/0.621\ \text{mi})(1\ \text{h}/3600\ \text{s}) = \underline{0.447\ \text{m/s}}$

   Another useful form is 1 km/h = 0.278 m/s.

7. (a) $\langle v \rangle = \dfrac{d}{t} = (8 \times 0.25\ \text{mi})/(13.5\ \text{min}) = 0.148\ \text{mi/min}$

   $\langle v \rangle = (0.148\ \text{mi/min})(60\ \text{min/h}) = \underline{8.9\ \text{mi/h}}$

   (b) Average vel = $\underline{0}$ since displacement = 0

8. 

$$\langle v \rangle = \frac{d}{t} = \frac{150 \text{ m}}{(8.4 + 2.8)\text{s}}$$

$\langle v \rangle$ = $\underline{13.4 \text{ m/s}}$

$$\langle \bar{v} \rangle \text{ (average vel)} = \frac{\text{Displacement}}{\text{time}} = \frac{50 \text{ m}}{11.2 \text{ s}}$$

$\langle \bar{v} \rangle$ = $\underline{4.46 \text{ m/s}}$

9. $$t_{1\text{st part}} = \frac{d_1}{v_1} = \frac{2100}{1000} = 2.1 \text{ h}$$

$$t_{2\text{nd part}} = \frac{d_2}{v_2} = \frac{1300}{800} = 1.625 \text{ h}$$

$$\langle v \rangle = \frac{D_{\text{total}}}{t_{\text{total}}} = \frac{3400 \text{ km}}{3.725 \text{ h}} = \underline{913 \text{ km/h}}$$

10. Speed = 2 × 120 km/hr = 240 km/hr

$$\text{time} = 8.5 \text{ km}/240 \text{ km/hr} = 0.0354 \text{ hr} \times \frac{60 \text{ min}}{1 \text{ hr}} = 2.1 \text{ min}$$

11. $$\text{time of sound from pins} = \frac{16.5 \text{ m}}{340 \text{ m/s}} = 0.048 \text{ s} = 0.05 \text{ s}$$

time of ball = 2.50 s − 0.05 s = 2.45 s

$$\text{speed} = \frac{16.5 \text{ m}}{2.45 \text{ s}} = 6.73 \text{ m/s}$$

12. ΔU = 100 km/h

$$= \left[\frac{100 \text{ km}}{\text{h}}\right]\left[\frac{1000 \text{ m}}{\text{km}}\right]\left[\frac{1 \text{ h}}{3600 \text{ s}}\right]$$

ΔU = 27.8 m/s.

$$\langle a \rangle = \frac{\Delta U}{\Delta t} = \frac{27.8 \text{ m/s}}{6.6 \text{ s}} = \underline{4.2 \text{ m/s}^2}$$

13. $$\Delta t = \frac{\Delta U}{\langle a \rangle} = \frac{(100 - 85) \text{ km/h}}{1.7 \text{ m/s}^2}$$

$$\Delta t = \frac{\left[\frac{15 \text{ km}}{\text{h}}\right]\left[\frac{1000 \text{ m}}{\text{km}}\right]\left[\frac{1 \text{ h}}{3600 \text{ s}}\right]}{1.7 \text{ m/s}^2} = \frac{4.17 \text{ m/s}}{1.7 \text{ m/s}^2}$$

Δt = $\underline{2.45 \text{ s}}$

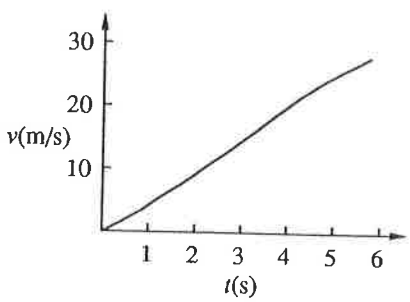
14. Use eq (2–10c). $0 = (27.8\ \mathrm{m/s})^2 + 2a(45\ \mathrm{m})$,
$a = \underline{-8.59\ \mathrm{m/s^2}} = (-8.59\ \mathrm{m/s^2})/(9.8\ \mathrm{m/s^2/g}) = \underline{-0.877\ g}$.

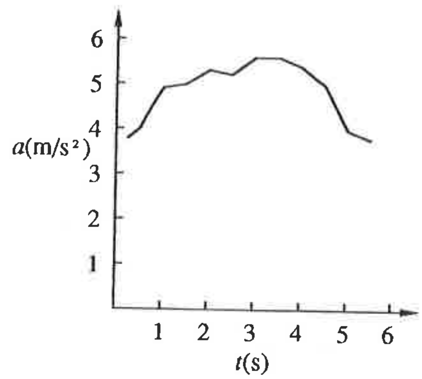
15. If we know the displacement at $T1$ is $X1$, and at $T2$ is $X2$ then at the average time $T = (T1 + T2)/2$ we may estimate the velocity as $V = (X2 - X1)/(T2 - T1)$ e.g. $X2 = 1.06$ m, $T2 = 0.75$ s; $X1 = 0.46$ m, $T1 = 0.5$ s. Thus $V = (1.06\ \mathrm{m} - 0.46\ \mathrm{m})/(0.75\ \mathrm{s} - 0.5\ \mathrm{s}) = 2.4$ m/s and $T = 0.625$ s. Thus,

t(s)	0.125	0.375	0.625	0.875	1.25	1.75	2.25
v(m/s)	0.44	1.4	2.4	3.52	5.36	7.86	10.5
t(s)	2.75	3.25	3.75	4.25	4.75	5.25	5.75
v(m/s)	13.1	15.9	18.7	21.4	23.9	25.9	27.8

Note we started with 15 times but now only 14 are left. We may similarly estimate the acceleration, $A = (V2 - V1)/(T2 - T1)$.

t(s)	0.25	0.5	0.75	1.0	1.5	2.0	
a(m/s²)	3.8	4.0	4.5	4.9	5.0	5.3	
t(s)	2.5	3.0	3.5	4.0	4.5	5.0	5.5
a(m/s²)	5.2	5.6	5.6	5.4	5.0	4.0	3.80





A BASIC program to implement this procedure is: / INPUT T2 / INPUT X2 / For B = 1,14 / T1 = T2 / X1 = X2 / INPUT T2 / INPUT X2 / T = (T2 + T1)/2 /V = (X2 – X1) / (T2 – T1) / PRINT T / PAUSE / PRINT V / PAUSE / NEXT B /.

(a) 0.44 m/s, 1.4 m/s, etc.

(b) 3.8 m/s², 4.0 m/s², etc.

16. $\underline{v = at}$, $\underline{x = at^2/2}$, $\underline{v^2 = 2ax}$, $\underline{\bar{v} = v/2}$

17. (a) Use eq (2–10a). $0 = (25)^2 + 2a(120)$; $\underline{a = -2.6\ \text{m/s}^2}$

(b) Use eq (2–10b) $x = (12)(5) + 0.5(2.6)(5)^2 = \underline{93\ \text{m}}$

18. Using (2–10)c.
$0 = (25\ \text{m/s})^2 - 2a(120\ \text{m})$
$\underline{a = 2.6\ \text{m/s}^2}$

19. Using (2–10c)
$(80\ \text{m/s})^2 = 0 + 2(a)(1500)$
$a = \underline{2.1\ \text{m/s}^2}$

20. Use eq (2–10a). $0 = 30\ \text{m/s} + (a/6\ \text{s})$, $a = -5\ \text{m/s}^2$.
Use eq (2–10b). $x = (30\ \text{m/s})(6\ \text{s}) - 0.5(5\ \text{m/s}^2(6\ \text{s})^2) = \underline{90\ \text{m}}$.

21. Use eq (2–10c). $0^2 = v^2_0 - 2(10)(320)$, $\underline{v_0 = 80\ \text{m/s}}$

22. $v_0 = (90\ \text{km/h})[0.278(\text{m/s})/(\text{km/h})] = 25.0\ \text{m/s}$

(a) Use eq (2–10c). $0 = (25)^2 + 2(-1.6)d$, $\underline{d = 195\ \text{m}}$

(b) Use eq (2–10a). $0 = 25 + (-1.6)t$, $\underline{t = 15.6\ \text{s}}$

(c) Use eq (2–10b).
In 1 s: $x_1 = (25)(1) + 0.5(-1.6)(1)^2 = \underline{24.2\ \text{m}}$
In 2 s: $x_2 = (25)(2) + 0.5(-1.6)(2)^2 = 46.8\ \text{m}$
In 3 s: $x_3 = (25)(3) + 0.5(-1.6)(3)^2 = 67.8\ \text{m}$
Therefore during the third second, it travels $(68.3\ \text{m} - 47\ \text{m}) = \underline{21.0\ \text{m}}$.

23. $v_0 = (60\ \text{km/h})[0.278(\text{m/s})/(\text{km/h})] = 16.7\ \text{m/s}$
Use eq (2–10c). $0^2 = (16.7)^2 + 2a(0.7)$, $a = -200\ \text{m/s}^2$
Deceleration $= -a = (200\ \text{m/s}^2)[1g/(9.8\ \text{m/s}^2)] = \underline{20\ g}$

24. $80\ \text{km/hr} \times 1000\ \text{m/km} \times 1\ \text{hr}/3600\ \text{s} = 22.2\ \text{m/s}$

(a) Use eq (2–10b). Distance traveled before reacting is 22.2 m.
Use eq (2–10c). $0 = (22.2\ \text{m/s})^2 + 2(-4\ \text{m/s}^2)d$, $d = 61.6\ \text{m}$.
Total distance is $\underline{83.8\ \text{m}}$.

(b) Again, $0 = (22.2\ \text{m/s})^2 + 2(-8\ \text{m/s}^2)d$, $d = \underline{30.8\ \text{m}}$.
Total distance = $\underline{53.0\ \text{m}}$.

25. Difference in "reaction distance" is d = (22.2 m/s)(1 s − 0.4 s) = 13.3 m.
Therefore distance is

(a) (83.8 m − 13.3 m) = 71 m, or

(b) (53 m − 13.3 m) = 40 m.

26. Distance before brakes hit = $x_0 + v_0 t_R$
Distance after brakes hit:

$$x = x_0 + \frac{v^2 - v_0^2}{2a}$$

$$= v_0 t_R + \frac{v^2 - v_0^2}{2a}$$

$$x = v_0 t_R - v_0^2/2a$$

27. Use eq (2–10c). Her initial speed is 50 km/h = 13.9 m/s. Her stopping distance is $-v^2/2a$ = 16 m, which is less than 30 m to intersection.
Use eq (2–10a) to calculate her acceleration as $(v - v_0)/t$ = (5.55 m/s)/7 s = 0.793 m/s².
In 2 s she can travel, eq (1–10b),
x = (13.9 m/s)(2 s) + 0.5(0.794 m/s²)(2 s)² = 29.4 m
which is less than the (30 m + 12 m) needed to make the light.
She should brake.

28. Time left 120 s. Assume accelerates for time t to speed v then cruises.
Intial speed is (4200 m)/(660 s) = 6.36 m/s.
Distance during acceleration = (6.36 m/s)t + 0.5(0.2 m/s²)t^2.
Cruise time is 120 − t = d/v = (800 − 6.36 t − 0.1 t^2)/(6.36 + 0.2 t).
Quadratic is
0.1 t^2 − 24 t + 36.8 = 0. t = 1.54 s

29. $280 \text{ m/s}^2 \times \frac{1 \text{ g}}{9.80 \text{ m/s}^2} = 28.57 \text{ g} = 29 \text{ g}$

30. Use eq (2–10b). h = 0.5(9.8)(3.5)² = 60 m

31. (a) Use eq (2–10b). −50 = (−9.8)t^2/2, t = 3.19 s

(b) Use eq (2–10a). v = 0 + (−9.8)(3.19) = −31.3 m/s

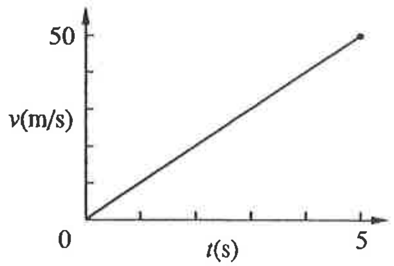
32. (a) Use eq (2–10c). 0 = (24)² − 2(9.8)h, h = 29.4 m

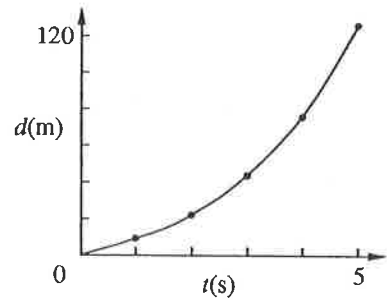
(b) Total displacement is zero. Use (2–10b). 0 = (24)t − 0.5(9.8)t^2, t = 4.90 s.
t = 0 is the trivial solution corresponding to zero displacement also.

33. Use (2–10c). $0 = v_0^2 + 2(-9.8\ \text{m/s}^2)(2.8\ \text{m})$, $v_0 = 7.41$ m/s.
Use (2–10b), displacement is zero. $0 = (7.41\ \text{m/s})t + (-9.8\ \text{m/s}^2)t^2/2$, $\underline{t = 1.5\ \text{s}}$.

34. Use eq (2–10b). $0 = v_0(4) + 0.5(-9.8)4^2$, $v_0 = 19.6$ m/s.
Use eq (2–10c). $0 = (19.6)^2 + 2(-9.8)h$, $h = 19.6$ m.

35. $v = gt$, $d = gt^2/2$





36. Use eq (2–10c). $0 = (1\ \text{m/s})^2 - 2a(0.035\ \text{m})$, $\underline{a = 14\ \text{m/s, down}}$.

37. Use eq (2–10b) $120 = (6)t + (-9.8)t^2/2$, $t = 5.60$ s

38. Use eq (2–10a) for second stone. $15 = 9.8t$, $t = 1.53$ s.
Use eq (1–10b) to determine how far stone has fallen. $h_2 = (9.8)(1.53)^2/2 = 11.5$ m.
First stone has fallen $h_1 = (9.8)(2.53)^2/2 = 31.4$ m
$\Delta h = h_1 - h_2 = 19.9$ m

39. $y = y_0 + v_0t + \frac{1}{2}at^2$

Let $y_0 = 0$, $v_0 = 0$.

$y = \frac{1}{2}gt^2$

At 0 s, $y_0 = \frac{1}{2}g(0)^2 = 0g$ m

At 1 s, $y_1 = \frac{1}{2}g(1)^2 = \frac{1}{2}g$ m

At 2 s, $y_2 = \frac{1}{2}g(2)^2 = \frac{4}{2}g$ m

At 3 s, $y = \frac{1}{2}g(3)^2 = \frac{9}{2}g$ m

$y_1 - y_0 = \frac{1}{2}g$

$y_2 - y_1 = \frac{3}{2}g$

$y_3 - y_2 = \frac{5}{2}g$

At N s, $y_N = \frac{1}{2}g(N)^2 = \frac{N^2}{2g}$

At $(N + 1)$ s, $y_{N+1} = \frac{1}{2}g(N + 1)^2 = \frac{(N + 1)^2}{2}g$

$y_{N+1} - y_N = \frac{1}{2}g[(N + 1)^2 - N^2]$

$= \frac{1}{2}g[N^2 + 2N + 1 - N^2)$

$= \frac{1}{2}g(2N + 1)$

If N is an integer, $2N + 1$ is an odd integer.

40. Use eq (2–10c). $v^2 = v_0^2$, as displacement is zero.

41. (a) Use eq (2–10c). $v^2 = (20)^2 + 2(-9.8)(16)$, $v = \pm 9.30$ m/s

(b) Use eq (2–10a) $+9.3 = 20 - (9.8)t_+$, $t_+ = 1.09$ s.
$-9.3 = 20 - (9.8)t_-$, $t_- = 2.99$ s.

(c) Stone passes the same height twice, once when rising up, another when falling down.

42. Use eq (2–10b). $h = (9.8 \text{ m/s}^2)t^2/2$, where t is time to top of window.
$(h + 2.4 \text{ m}) = (9.8 \text{ m/s}^2)(t + 0.3 \text{ s})^2/2$. Subtract to find $t = 0.665$ s, and $\underline{h = 2.17 \text{ m}}$.

43. Time for sound is $(h/340)$s. Time of fall is $[3 - (h/340)]$s.
Use eq (2–10b). $h = (9.8)(3 - h/340)^2/2$, $h = 41$ m.

44. Since the water continues to fall for 2 seconds after the water is diverted, it takes two seconds for the last water to leave the nozzle and go up and then fall to the ground.
We are solving for the maximum nozzle speed.
Use eq (2–10b). up positive, $0 \text{ m} = 1.5 \text{ m} + vt - (0.5)(9.8 \text{ m/s}^2)t^2$
Assume minimum nozzle speed = 0 m/s
$t = 2$ s
$\underline{v = 9.05 \text{ m/s}}$.

45. (a) Use eq (2–10b). $-65 = (10)t + (0.5)(-9.8)t^2$, $\underline{t = 4.8 \text{ s}}$.

(b) Use eq (2–10a). $v = (10) + (-9.8)(4.8) = \underline{-37 \text{ m/s}}$.

(c) $d = |d_{up}| + |d_{down}| = 2d_{up} + h$
Use eq (2–10c).
$0 = (10)^2 + 2(-9.8)d_{up}$, $d_{up} = 5.1$ m
$d = 2(5.1) + 65 = \underline{75 \text{ m}}$

46. (a) Use eq (2–10c). $12^2 = v_0^2 + 2(-9.8)(30)$. up positive, $v_0 = \underline{27.1 \text{ m/s}}$.

(b) Use eq (2–10c). $0 = (27.1)^2 + 2(-9.8)h$, $h = 37.3$ m

(c) Use eq (2–10 b). $-30 = 12t + 0.5(-9.8)t^2$, $t = -1.5$ s or 4.0 s.
It was thrown 1.5 s ago.
Could also use eq (2–10a). $12 \text{ m/s} = 27 \text{ m/s} + (-9.8 \text{ m/s}^2)t$, $t = 1.5$ s

(d) It reaches street again at $t = \underline{4.0 \text{ s}}$.
Eq (2–10a). $-27 \text{ m/s} = 12 \text{ m/s} + (-9.8 \text{ m/s}^2)t$, $t = 4.0$ s

47. (a) At $t = 10$ s, slope of line = (2.8 m)/(10 s) = $\underline{0.28 \text{ m/s}}$.

(b) At $t = 30$ s., slope of line = (19 m − 8 m)/(35 s − 25 s) = $\underline{1.10 \text{ m/s}}$

(c) The velocity is constant for first 20 s, therefore from (a) $\underline{\bar{v} = 0.28 \text{ m/s}}$.

(d) $\bar{v}$ = (16 m − 8 m)/(5 s) = $\underline{1.6 \text{ m/s}}$

(e) $\bar{v}$ = (10 m − 20 m)/(10 s) = $\underline{-1.0 \text{ m/s}}$

48. (a) Whenever the curve is straight, i.e. 0–20 s.

(b) When slope is steepest in positive direction, $t \simeq 28$ s.

(c) When slope is zero $t = 37.5$ s.

(d) both. From 37.5 s on it is going backwards.

49. (a) 50 s

(b) 90 s to 107 s

(c) When curve is straight, 0 – 15 s; 65 s – 75 s; 90 s to 107 s.

(d) Magnitude means we can consider both positive and negative slopes. $t \simeq 70$ s

50. (a) Acc in 2nd year $= \dfrac{\Delta v}{\Delta t} = \dfrac{11\ \text{m/s}}{5\ \text{s}}$

$a_{\text{2nd gear}} \simeq 2.2\ \text{m/s}^2$

(b) Acc in 4th gear $= \dfrac{7.5\ \text{m/s}}{10\ \text{s}} \simeq 0.8\ \text{m/s}^2$

(c) We need area under curve $\sim 37.5 + 5 \times 7.5 = 75$ m.

51. Acc in 1st gear $= \dfrac{\Delta v}{\Delta t} \sim \dfrac{13\ \text{m/s}}{4\ \text{s}} = 3.3\ \text{m/s}^2$

Acc in 3rd gear $= \dfrac{12\ \text{m/s}}{7\ \text{s}} = 1.7\ \text{m/s}^2$

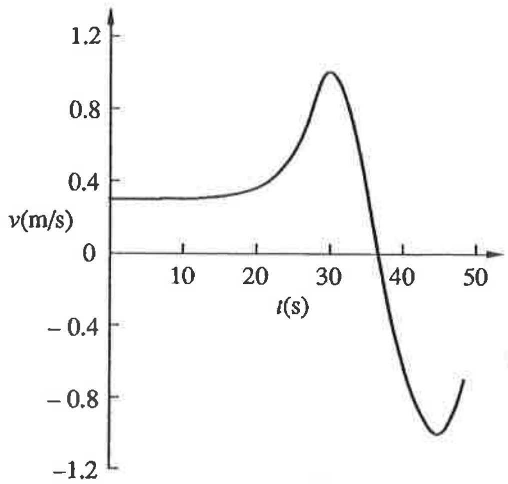
Acc in 5th gear $= \dfrac{8\ \text{m/s}}{23\ \text{s}} = 0.35\ \text{m/s}^2$

Acc in first 4 gear $= \dfrac{\Delta v}{\Delta t} = \dfrac{44\ \text{m/s}}{27\ \text{s}} \simeq 1.6\ \text{m/s}^2$

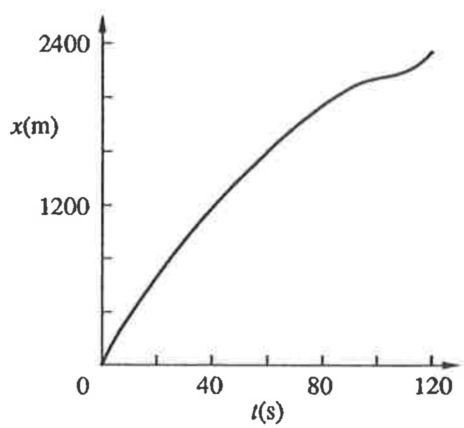
52. (a) Area under curve is distance $\simeq$ 17 squares $= 17 \times 10\ \text{m/s} \times 10\text{s} = 1700$ m.

(b) Area under curve $\simeq$ 5 squares $= 500$ m.

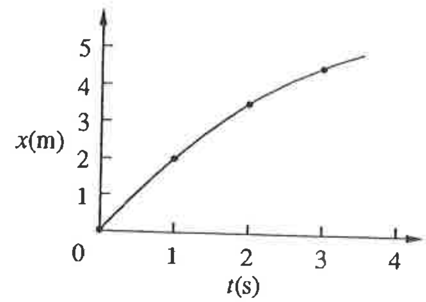
53. We must plot slope in m/s against t.



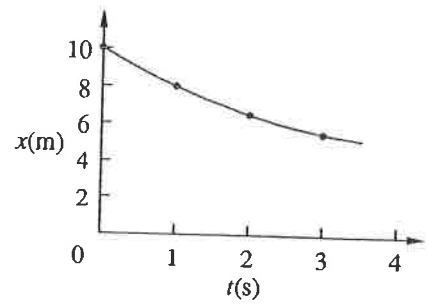
54. We plot area under curve as a function of time.



55. a.



b.



$\overline{v_{10}}$ = (2 m − 0 m)(1 s − 0 s) = <u>2.0 m/s</u>

$\overline{v_{21}}$ = (3.5 m − 2 m)/(2 s − 1 s) = <u>1.5 m/s</u>

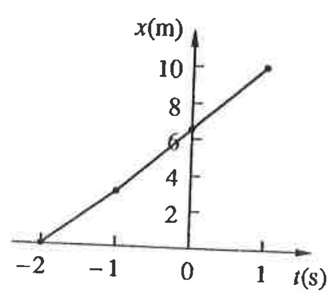
$\overline{v_{32}}$ = (4.5 m − 3.5 m)/(3s − 2s) = <u>1.0 m/s</u>

$\overline{v_{10}}$ = (8 m − 10m)/(1 s − 0 s) = <u>−2.0 m/s</u>

$\overline{v_{21}}$ = (6.5 m − 8 m)/(2 s − 1 s) = <u>−1.5 m/s</u>

$\overline{v_{32}}$ = (5.5 m − 6.5 m)/(3 s − 2 s) = <u>−1.0 m/s</u>

c.

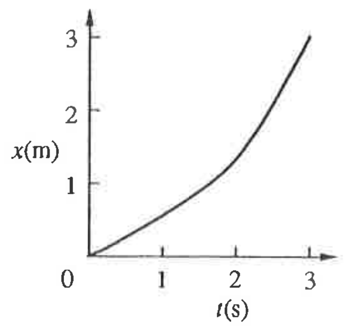


$\overline{v_{-2-1}}$ = (3.0 m − 0 m)/[−1 s − (−2 s)] = <u>3.0 m/s</u>

$\overline{v_{-10}}$ = (6.5 m − 3.0 m)/[0 s − (−1 s)] = <u>3.5 m/s</u>

$\overline{v_{01}}$ = (10.0 m − 6.5 m)/(1 s − 0 s) = <u>3.5 m/s</u>

56.



$\bar{v} = (3\ m - 1.333\ m)/(1\ s) = 1.667\ m/s$

$\bar{v} = (2.083\ m - 1.333\ m)/(0.5\ s) = 1.5\ m/s$

$\bar{v} = (1.610\ m - 1.333\ m)/(0.2\ s) = 1.39\ m/s$

$\bar{v} = (1.470\ m - 1.333\ m)/(0.1\ s) = 1.37\ m/s$

$\bar{v} \simeq 1.36$

57. $h = v^2/2g$
$(h_m/h_e) = (g/g_m) = 6$

. Using eq (2–10c). $\Delta x = v^2/2a = [(100\ km/h)0.278(m/s)(km/h)]^2/2/30/(9.8\ m/s^2) = 1.31$ m

59. Assume lap distance is L km. $t = d/v$.
Time for four laps is $t = (4L\ km)/(200\ km/h)$ = sum of times for first two laps plus second two laps $= (2L\ km)/(170\ km/h) + (2L/v)$. v = 243 km/h.

60. Number of cars is $\left[\frac{3 \times 100\ km/h}{0.086\ km/car}\right] = 3488$ cars/h $\simeq$ 3500 cars/h

61. $100\ m/[(90 - 60)km/h]/[0.278(m/s)/(km/h)] =$ 12 s.

62. First find acceleration using eq (2–10c). $(25)^2 = 2a(200)$, $a = 1.56\ m/s^2$.
Using eq (2–10c) again. $v^2 = 25^2 + 2(1.56)(290)$
$v = 30.1$ m/s

63. (a) v = 90 km/h = 25 m/s, N = 36000/800 = 45.
Total time = 45(800/25 + 25/2.2 + 25/4) + 44(20) = 3205 s = 52 min.

(b) 12(3000/25 + 25/2.2 + 25/4) + 11(20) = 1871 s = 31 min

64. N stretches, $(N - 1)$ intermediate stations.
a = acceleration, d = deceleration, max velocity = v, distance between stations = L,
time at each station = T.
Acceleration time v/a. Distance $v^2/2a$.
Deceleration time v/d. Distance $v^2/2d$.
Time for middle stretch = $(L - v^2/2a - v^2/2d)/v$.
Total time = $N(L/v + v/2a + v/2d) + (N - 1)T$.
Average speed = $L/[L/v + v/2a + v/2d + T(N - 1)/N]$

65. How high is the pelican 0.10 s before it hits the water? Time for pelican to reach surface:
$0 \text{ m} = 20 \text{ m} + 0.5(-9.8 \text{ m/s}^2)t^2$
t = 2.02 s.
At 2.02 s – 0.10 s = 1.92 s, fish must spot pelican. At this time, the pelican is at height
$20 \text{ m} + 0.5(-9.8 \text{ m/s}^2)(1.92 \text{ s})^2 = 1.93 \text{ m} = 1.9 \text{ m}$

66. Use eq (2–10c).
Putting downhill: $0 = v^2 + 2(-2 \text{ m/s}^2)8 \text{ m}$, or $0 = v^2 + 2(-2 \text{ m/s}^2)6 \text{ m}$.
Thus range is 4.9-5.6 m/s.
Putting uphill: $0 = v^2 + 2(-3 \text{ m/s}^2)8 \text{ m}$ or $0 = v^2 + 2(-3 \text{ m/s}^2) 6 \text{ m}$.
Thus range is 6.0-6.9 m/s.
The range for putting uphill is bigger.